# Energy conservation in pulp and paper mills

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SUMMARY

With the increase in the population and literary of our people, demand for paper and board is increasing day by day. Present installed capacity of paper and board is 21.65 Lakh tonnes per year with its small & big units. According to Planning Commisson by 2000 A.D. our paper and board production should reach 42.5 Lakhs tonnes. This production requires 46.4 Lakh tonnes of coal equivalent and 43,300 Lakhs K.W.Hr of electrical energy. Already the paper Industry is facing many problems and one of them is the energy crisis. The prices of fossil fuels are escalating day by day and paper mills economy is affected. Hence the paper industry should take necessary steps to minimise energy consumption by adopting process and equipment modification and changes, and should start utilising unconventional energy resources along with taking necessary in-plant measures for energy conservation. Incentives given by the Government should be utilised to procure new energy efficient equipments and help in conserving the energy.

Paper plays a vital role in the cultural development of humanity, and as such its consumption in any country or community is a direct indication of its development. Present per-capita consumption of paper in India is only 2.0 Kgs. with an installed capacity of 21.65 Lakh tonnes per year of paper and board. According to the Planning commission with the increase in the population and literacy, the paper and board production has to be increased to 42.5 lakh tonnes by 2000 A.D. This is expected to raise our percapita consumption to 4.5 Kgs. For this expansion of the Industry 46.4 Lakh tonnes of coal equivalent fuel and 43,300 Lakh Kwh of electrical power will be needed.[1] Already the paper industry is confronted with multifaced problems, one of the important one being the energy shortage caused by several reasons like poor coal quality, frequent power trippings and voltage fluctuations.

Energy is considered as the fourth economic factor of production, right after labour, land and capital. Large paper mills contributing to 75% of the paper and board production of the country have their own captive power generation plants, using steam from fuel fired and the recovery boilers. On the other-hand, small paper mills have to purchase their entire requirement of energy The cost of oil and coal is escalating day by day and nobody can predict what its cost will be in 2000 A.D. or after. Observing the impact of energy cost has, and will effect the overall working economy of the Paper Mills. To achieve this the Indian Paper Industry has to take urgent steps to minimise energy consumption and reduce its dependence on conventional biomass for steam generation by finding out alternate sources of energy. For this purpose the industry has to check thoroughly and innovate new system of energy conservation in following three areas.

i) Use of unconventional energy sources.

ii) Equipment and Process modification.

iii) In plant measures.

## USE OF UNCONVENTIONAL ENERGY SOURCES

### Bark and Hogged Fuel :

Due to non-availability of bamboo, paper mills are forced to use hard woods for pulping. Day by day its consumption is increasing which is expected to be substantial by 2000 A.D. Bark comprises at least 20% of the weight of the wood log, which means that it makes up about 10% of the total biomass of the whole tree. Generally

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debarking operation is carried out in the forest and bark is left behind as waste. The average heating value of bark is around 2200 K. Cal/Kg. with 50% moisture content in it. Bark has a greater potential to substitute fossil fuels currently used in the paper industry. A similar waste fuel is hogged fuel as waste from lumber operation. Fine bamboo dust obtained during chipping and saw dust is further available. Hogged fuel has on an average heating value of 2000 K. Cal/Kg. with 50% moisture content.[2] For the efficient burning of these materials and to generate steam, sloping grate boilers are available which do not need any aid of auxilliary fuel support. Therefore, if adequate arrangements are needed to collect bark from the forest area, where it is presently left behind, at reasonable costs it can prove substantial source of energy recovery for a paper mill using wood.

**Mill Sludge Utilisation :**

From effluent treatment plants, sludge is the byproduct. Normally sludge is thickned and disposed off as land fill, but it consists of organic material which is biodegradeable. Anaerobic decomposition of cellulosic material is a common natural process accuring in lake sediments, landfill waste disposal sites and in the stomachs of ruminating animals.[3] A 150 TPD pulp and paper mill discharges a minimum of 3 TPD of organic sludge (on dry basis) from its effluent treatment plant. By anerobic digestion under mesophilic or thermophilic conditions[4] this sludge produces 60% methane gas. By digesting one tonne of sludge 200 $M^3$ of biogas equivalent to 1000 Kwh can be produced. This gas can be used to obtain thermal energy. The slurry obtained after digestion is very good as manure. If the cow dung is blended with mill sludge for digestion, the added advantages will be to get biogas as well as manure for agricultural use.

**Utilisation of Hydrogen Gas :**

Many of the integrated pulp and paper mills have their own caustic chlorine plant. An integrated pulp and paper mill of 150 TPD paper and board production with a 20 TPD caustic chlorine plant produces 250 $Nm^3$/hr of hydrogen gas. The calorific value of this gas is 2000 K cal/kg.[5] Due to its hazardus nature this highly valuable gas is vented out as waste. A safer hydrogen combustion equipment can be utilised to burn this gas to supplement fuel demand.

**Harnessing Solar Energy :**

Solar energy received by the earth's surface varies depending upon the attenuation due to atmosphere, weather, declination of Sun at the place and hour of the day. Our country is favourablly located between 8°N and 38°N latitudes for receiving solar energy. The sunny days in our country range from 200 to 300 days in any year.[6] On an average, we receive 6 kwh/$m^2$ per day. This fact should be taken as an advantage. The solar energy received at any place consist of direct or beam radiation and diffuse radiation. The beam radiation can be reflected and concentrated while diffuse radiation has to be used as such and cannot be concentrated. There are two kinds of solar energy collectors. First is the flat plate collectors which accepts all the energy both beam and diffuse and use without concentration, these can be used for obtaining temperature below 100°C. Second one is the concentrator, which reflects only the beam radiation to a point or line focus and so attains higher temperature upto 3000°C. We should concentrate our efforts to utilise both the beam and diffuse radiation by receiving them on solar flat plate collectors to raise hot water. Large spaced solar plate which collect 2–3 kwh/$m^2$ per day can be installed on the top of factory buildings. A combination of solar water heaters, biogas and hydrogen gas can substantially contribute energy for generating hot water supply required for pulp washing process, etc.

## EQUIPMENT AND PROCESS MODIFICATION

**Chipping :**

New designs of high capacity chippers have lower running cost. The ratio of no load current to operating current of higher capacity chippers is much less than those of lower capacity. Chippers are having no-load current machines and their capacity utilisation directly affects the energy conservation. It is always economical to go for higher capacity chippers. Pneumatic transport of chips by blowers is always more power consuming than conveying through belt conveyers, and therefore, efforts should always be made to adopt the later system in chip handling.

**Blow Heat Recovery :**

In many old mills with batch digesters, blow heat recovery system does not exist for several reasons. During blowing about 0.7-0.8 tonnes of steam per tonne of pulp is flashed out. It is necessary to trap this huge quantity of energy escaping to atomosphere. A simple technique has been developed to trap this heat by displacement heating and cold blowing technique.[7] By adopting this technique about 75% of steam requirement for cooking is reduced along with rise in black liquor concentration.

The other system to extract blow heat is to install a heat pump. The function of heat pump

is to raise the temperature of low grade heat energy to a more useful level, using relatively small amount of high grade energy.

**Brown Stock Washers :**

In many paper mills brown stock washing consists of three counter current streams. By adding one more washing stream to the existing, the benefits like (1) obtaining of higher concentrated black liquor (2) controlled dilution factor (3) reduced steam consumption for black liquor evaporation (4) more chemical recovery and (5) reduced pollution load on effluent treatment plant.

**Refiners :**

Stock Preparation is a power intensive process. The system adopted for rifining should be carefully considered keeping in view of the fibre property. Efficient refiners like disc and double disk refiners, which consume least power can be installed looking into the fibre quality. Disk refiners' power consumption can be further reduced by adopting efficient speed regulation system.

**Paper Machine :**

Mechanical removal of water from wet paper web requires less energy than by steam drying. A 1% change in dryness effects a 4% change in steam consumption Old machines should be converted to thyrister controlloed D.C. drive which reduces power consumption significantly. Apart from this proper ventilation of vapours in the drying section play an important role in machine production and steam conservation. A Proper hood system will serve this purpose. Other simple measures like proper felting, use of better forming wires and felts will help in considerable reduction of energy.

**Steam Generation :**

There is a large conservation potential in steam generation in fuel fired and recovery boilers. Monitoring of and close regulation of excess air can produce important saving. Air heaters/ economisers should be installed wherever it is possible for flue gasses leaving the boilers. Proper control of total dissolved solids and boiler water quality and flash steam recovery from blow down will also result in fuel saving. Recovery Boiler operational stability largely depends on the proper regulation of solids content of Black Liquor and viscosity. Large variation in solids content and viscosity results in unstable operating conditions of recovery boiler necessitating consumption of large amount of oil support.

## IN PLANT MEASURES

In plant measures are considered as important component of energy conservation policy. These are invisible sources of energy which can be controlled at relatively low costs.

**Chipping :**

Chipping is a high power intensive operation. By minimising idle running time, and suitable modification in electrical devices in starters and motors, energy consumption can be very effectively brought down. Design of chippers and knife setting also plays important role in achieving energy efficiency.

**Digester House :**

Digester House needs large quantities of heat energy. This is due to the use of large vertical stationary batch digesters. Direct cooking needs about 4.0 tonnes of steam per tonne of pulp and also dilutes the liquor concentration. By adopting to indirect heating steam consumption per tonne of pulp can be reduced to 2.7 tonnes. Another way of energy conservation is to have sequential cooking and maintain constant 'H' factor, which results in uniform steam consumption and uniform pulp quality respectively. By adopting displacement heating and cold blowing as described in item No. 3 2 will reduce the energy requirement from this section.

**Pulp Washing and Bleaching :**

The two important factors which affect the energy efficiency of brown stock washing and bleaching operations are the specific power consumption and their design and operation to utilise minimum fresh water and its availability to use the maximum recycled water in closing the Mill water circuit. In brown stock washing attempts should be made to control the dilution factors and the chemical losses closely with the aids of instrumentation. In bleach plant efforts should be made to recycle the filtrate as far as possible which not only saves energy and chemicals but also minimise pollution load. As far as possible double handling of the pulp should be avoided.

**Insulation :**

Insulation plays a very vital role in the conservation of energy to keep the heat losses by radiation to minimum. Optimum thickness of the insulation is necessary to have minimum heat losses. Steam lines, valves and flanges, hot liquor lines, valves and flanges, hot liquor lines, tanks and even seal tanks should be properly insulated with suitable insulating material. Dryer cylinder sides in paper machines should also be insulated. It is advantageous to insulate the refractory walls of the boilers to minimise radiation losses. Special care should be taken to install proper steam traps so that they

work effectively to stop undue loss of steam.

**Electrical Energy Conservation**

In paper industry most of the electrical energy is consumed by motor drives. Hence any conservation effort has to start from the motors.

**Over size motors**

Use of over sized motors were once considered for safety against motor failure and burning but now-a-days this concept is not accepted for the reason of energy wastage.

**Improved Power Factor**

As far as possible higher power factor motors should be purchased. With the existing and old motor's power factor can be improved by adding capacitors to them.

**Old Motors**

Majority of the motors in the Paper Industry are Old Motors. They are 4 to 5% less efficient than the new models. As far as possible they should be either replaced or shifted to lower usage levels. It is also desirable that in less critical areas, these lower rated motors less than 55% loading are converted from Delta connection to Star connection. By this the efficiency of the motors goes up and gives a better power factor than delta connection.

## CONCLUSION

To meet the challanges of Energy Conservation and minimising dependence on fossil fuel, the Government of India has set up a separate section of Non-conventional Energy sources in the ministry of Energy, which encourages the use of non-fossil fuels. It also aids Institutions to carryout research to develop other sources of energy. Bark fired boilers, Biogas generation, Instalation of Solar Heaters and Equipment/Process, modifications are capital intensive in nature For the installation of these energy saving equipments by the paper mills, the Government of India has come forward by offering incentives like accelerated depreciation[8], investment allowances and leasing. The paper mills should avail this right opportunity to modernise the industry by conserving teh energy.

Energy conservation in any Industry does not necessarily need experts from outside to help the mill personnel. It is the will and determination of the engineers and scientists working in the Mill, that are needed to unearth the points where energy is either extravagantly used or is being wasted for no reasons. If due attention is paid by the personnel, there is no reason why conservation and wastages can not be reduced effectively and economically.

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